antennas & things

Simple Antennas And Accessories For Signal Improvement

What On Earth Is EMC And EMI?

Electromagnetic compatibility (EMC) and electromagnetic interference (EMI) are critical to shortwave listeners and scanner receiver operators. The reason is that the receivers that we use are electronic devices, and as such they are expected to perform two functions:

1. To respond properly to desired signals, and

2. They are not supposed to respond to undesired signals.

The problem is not the first of these things. Our receivers usually respond properly to the signals that we try to pick up, and demodulate the signal properly. The problem is in the second of these: They are not supposed to respond at all to *undesired* signals. The fact is simple: radio receivers often respond to signals that they are not supposed to respond to, often with disastrous results.

Regulatory Issues

The military has long recognized a severe EMI/EMC problem. Their equipment must perform, and perform well, in the presence of fields as strong as 10,000 volts per meter (V/m). The military even has a couple of specifications on EMI/EMC. Their MIL-STD-461 and MIL-STD-462 (in various versions) have traditionally been used for the EMI/EMC requirements, but have recently been replaced by MIL-STD-461E (which combines '461 and '462).

The European Community issued directive 89/336/EEC to cover the EMI/EMC field. That directive carries criminal penalties, and requires all electronic products to be tested for compliance. The European Community EMI/EMC directive requires every manufacturer or importer of electronic apparatus make a "Declaration of Conformity" for the unit. The "CE" mark must appear on the equipment at least 5 mm high, and be indelibly affixed to the unit (ever wondered what that "CE" mark meant?). Failure to conform to the directive can lead to jail.

The International Electrotechnical Commission and the Organization for International Standards (issuers of the

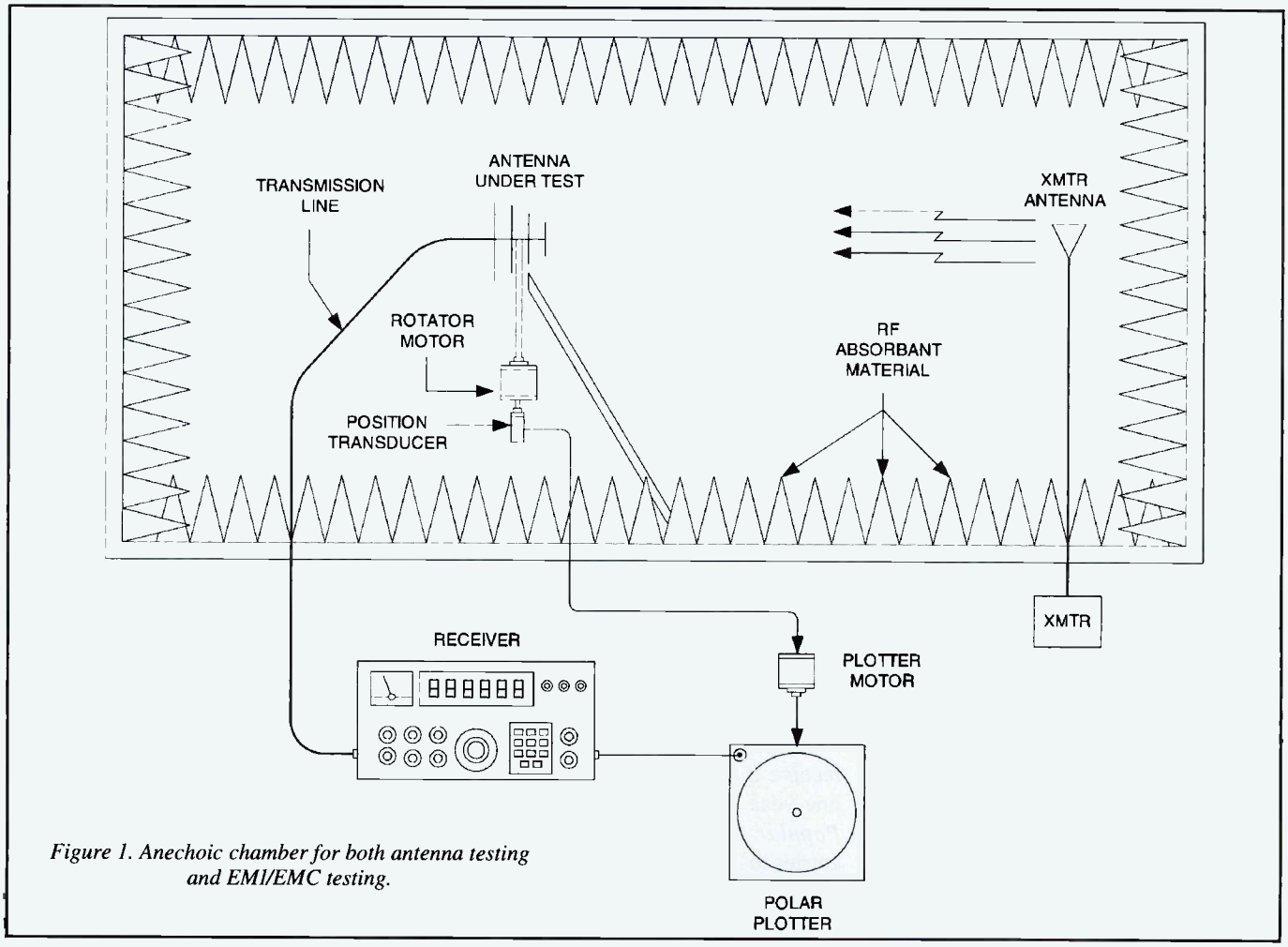

Figure 1. Anechoic chamber for both antenna testing and EMI/EMC testing.

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famous "ISO-xxxx" series of documents) work closely together. Both are located in the Swiss city of Geneva. The International Special Committee of Radio Interference (CISPR after the French) is the IEC committee that works mostly on EMI/EMC issues. The European Telecommunications Standards Institute (ETSI) and the European Organization for Electrotechnical Standardization (CENELEC) are two organizations that cooperate with the IEC (even though their mandate is solely European) on EMI/EMC matters. In the United States, the American National Standards Institute (ANSI) and the Institute of Electrical and Electronic Engineers (IEEE) are the responsible parties, with input from the Federal Communications Commission.

The technical vocabulary of EMI/ EMC is given in a document called IEC-50. It has definitions given in three languages (English, French, and Russian). It also has a number of terms in Dutch, German, Italian, Polish, Spanish, and Swedish.

IEC-801 defines compliance of electronic units. IEC-801-2 defines testing for electrostatic discharge (ESD), while IEC-801-3 defines equipment for industrial process management and control. Another important IEC document is IEC-1000.

There are a number of standards in EMI/EMC besides 461/462. If a standard begins with a "BS," it is a British standard, while an "EN" prefix denotes a European standard ("Norme" is the French word for "standard" and is the "N" in "EN"). Some standards are issued as both BS and EN types. For example, BS-800 (on radio interference) is also EN-55014. The "14" in EN-55014 denotes that the standard is derived from CISPR 14.

EN-50081 (Emissions) and EN-50082 (Immunity) are generic standards for equipment that are not covered by other standards. If other standards exist, then they take precedence over EN-50081 and EN-50082.

BS-6527, also known as EN-55022 and CISPR 22, specifies that between 30 and 230 MHz the electrical field 10-meters from digital equipment not be 30 (V/m). That is a lot of interfering signal to be radiated into a receiver! It might not be sufficient for on-channel interference, yet it is the most severe civilian standard in the world.

U.S. Standards

The FCC publishes radio interference standards in the USA, with input from ANSI and IEEE. Part-15 CFR 47 (Code of Federal Regulations) defines the EMI/ EMC world of unintentional interference. It recognizes two main classes: **Class-A for business or industrial use, and Class-B for domestic use.** Class-B is stricter than Class-A because radio receivers and television receivers are susceptible to EMI/ EMC. Publication *FCC/OET MP-4* describes how to measure the interference emitted by computers and other devices.

Europeans use the same "class-A/B" designation as the USA. In Europe, a Class-B device is (generally speaking) one that operates from a 13-ampere outlet.

Conformance Testing

Conformance testing is done in anechoic chambers (Fig. 1) or on Open Area Test Sites. Figure 2 shows a typical OATS that conforms to EN-55022. If the funds and facilities are available, then an indoor anechoic range (Fig. 1) is preferred. The cones shown in Fig. 1 are 2.5-meters in length at 30-MHz, although they are smaller for VHF/UHF ranges.

The data collected are of far greater usefulness than the data collected outdoors, especially off-the-air. The indoor range is simply a more easily controlled, predictable environment.

The indoor range consists of a room lined with materials that absorb radio waves. Usually in the form of pyramid

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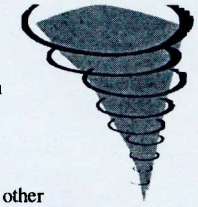

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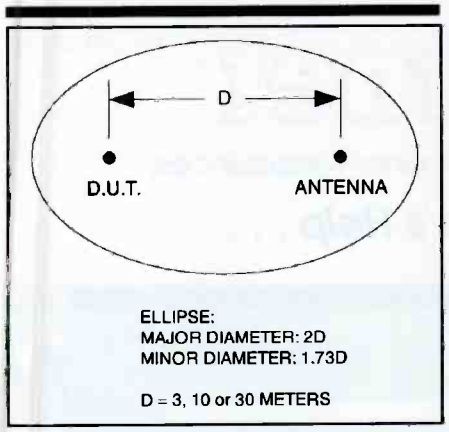

Figure 2. OATS facility.

shaped wedges, various sizes of absorbers are placed over all surfaces of the chamber. The room is inside of a *Faraday cage*. This shielding provides protection against both signals from outside interfering with the test, and reflections of the reference signal from structures outside of the chamber. A point source, such as a small loop at UHF and below, or a horn radiator at microwave frequencies, is positioned at one end of the room.

The same type of range can be used for antenna patterns. The antenna is mounted on a rotatable pedestal. In order to prevent secondary reflections from the pedestal, blocks of absorbent material are often used to block the view of the pedestal from the radiator. Both elevation and azimuth plots can be made by the simple expedient of mounting the antenna in the correct plane for each test.

In antenna measurements, the polar pattern of the antenna is created by using a servomotor or position transducer to rotate a chart recorder that measures the output strength of the receiver. The result is the familiar antenna azimuthal or elevation patterns.

Modern versions of the indoor range use a computer rather than the polar plotter shown in **Figure 1**. The output of the receiver is a voltage indicating signal level, so it can be A/D converted for input to the computer. The position transducer can also provide data to the computer. Once these data are in, a plotting program can draw the polar plot.

One advantage of the computer approach is that a static profile of the chamber can be made by mounting a reference antenna in place of the AUT or DUT. The plot can then be made, and note taken of any reflections or other anomalies that exist in the chamber. These data can then be compared with the data for the AUT or DUT at each angle, with the AUT data adjusted to account for directional differences.

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The advantage of the indoor test facility is that it allows test engineers and technicians to rotate the DUT in any attitude required for the measurements.

The Open Area Test Site (OATS) is used out of doors. An EN-55022 compliant OATS (one of two) is shown in **Figure 2.** The typical OATS is an ellipse with major and minor axes. The Device Under Test (DUT in Fig. 2) and antenna for the test signals are on the metal ellipse. The dimension "D" may be 3-meters, 10-meters, or 30-meters depending on the size of the DUT. The major axis is 2D and the minor axis of the ellipse is 1.73D.

The nature of the OATS ground screen depends on the frequencies for the ellipse. It can be a screen, but the "holes" in the screen should not be a major part of one wavelength at the lowest frequency of operation. The holes in the mesh should be 33-mm, which is one-tenth wavelength at 1 GHz. That is usually not a problem, but the minimum and maximum frequencies of the OATS must be considered.

For straight EMI/EMC testing, the OATS is sufficient because reflections don't bother EMI/EMC tests are much as it does antenna patterns. Nonetheless, care must be taken to locate the OATS where there are no other structures, overhead wires, or other structures that reflect radio frequency energy used in the test.

The test site should have a RF-friendly structure for the electronics and personnel involved. A glass-reinforced polyester (GRP) facility is often used to avoid RF reflections. A better approach is to put the control electronics and control room below ground.

Screened Rooms

A decent job of EMI/EMC testing can be done inside a screened room, rather than an anechoic chamber. The cost of the anechoic chamber is prohibitive for many users (although one can be rented for a few thousand dollars per day). The screened room is basically a Faraday cage. The size of the screened room is 4 x 5 x 3 meters. In IEC-801-3, however, the size of the screened room will be increased to 6 x 5 x 3 meters.

EMI/EMC is a very important topic for the SWL/monitor community. Next time, I will try to discuss some of the tests and investigations one can undertake to understand the EMI/EMC performance of the radios you use. ■